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Mark Scheme (Results)
January 2011

GCE

GCE Physics (6PH01) Paper 01

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January 2011

Publications Code US026587

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Mark scheme notes

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

For example:

(iii) Horizontal force of hinge on table top

66.3 (N) or 66 (N) **and** correct indication of direction [no ue] ✓ **1**
[Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

1. Mark scheme format

1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the ms has specified specific words that must be present. Such words will be indicated by underlining e.g. 'resonance'
1.2 Bold lower case will be used for emphasis.
1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties

2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.
2.2 Incorrect use of case e.g. 'Watt' or 'w' will **not** be penalised.
2.3 There will be no unit penalty applied in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.
2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).
2.5 Occasionally, it may be decided not to penalise a missing or incorrect unit e.g. the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.
2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. Significant figures

3.1 Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in 'show that' questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.
3.2 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

4. Calculations

4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.

4.2 If a 'show that' question is worth 2 marks then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.

4.3 **use** of the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.

4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.

4.5 The mark scheme will show a correctly worked answer for illustration only.

4.6 Example of mark scheme for a calculation:

'Show that' calculation of weight

Use of L × W × H ✓

Substitution into density equation with a volume and density ✓

Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] ✓
[If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark]
[Bald answer scores 0, reverse calculation 2/3] **3**

Example of answer:

80 cm × 50 cm × 1.8 cm = 7200 cm^3

7200 cm^3 × 0.70 g cm^{-3} = 5040 g

5040 × 10^{-3} kg × 9.81 N/kg

= 49.4 N

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

6. Graphs

6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

6.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

6.5 For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Answer	Mark
1	D	**1**
2	C	**1**
3	A	**1**
4	B	**1**
5	D	**1**
6	D	**1**
7	D	**1**
8	C	**1**
9	B	**1**
10	B	**1**

Question Number	Answer	Mark
11*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) (N1:) No acceleration / constant velocity ('constant speed' not sufficient)/ (at rest or) uniform motion in straight line (1) unless unbalanced/net/resultant force (1) [Converse: If $\Sigma F = 0$ / forces in equilibrium ('body in equilibrium', 'equal forces' not sufficient) 1 mark, there is no acceleration ('remains at rest' not sufficient)1 mark] (N2:) acceleration proportional to force / F = ma (1) Qualify by stating resultant/net force / $\Sigma F = ma$ (1) (Reference to 'resultant' for N2 may be credited elsewhere in the answer as they don't always put it with F = ma, but it must be clearly linked to N2.) ('External force' not sufficient) (For answers based on momentum, 'rate of change of momentum' proportional to force / $F = \Delta(mv)/\Delta t$) If (resultant) force zero, N2 → acceleration = 0 **OR** acceleration only non-zero if (resultant) force non-zero. (1) Names reversed, max 1 per each correctly, fully defined law (i.e. max 3) Last mark not awarded if laws not explicitly identified within question	
	Total for question 11	**5**

Question Number	Answer	Mark
12*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Small extension hard to measure accurately (or converse) (1) Small extension gives large percentage uncertainty (or converse) (1) **Max 4 from** (thin wire has) small area (1) stress = force/area (1) so get a larger stress (for a given force) / don't need such a large force / need too much force needed if not thin (1) greater extension - linked to thinner wire (1) strain = extension/original length / extension original length (1) greater extension - linked to longer length (1) _____ (Alternative to equation marks: Young modulus = stress / strain or $E = Fx / A\Delta x$ (accept alternative symbols) scores 1 mark, rearranged to make extension the subject scores 2 marks) Accept converse arguments (Ignore references to breaking or surface, as in surface area)	**Max 5**
	Total for question 12	**5**

Question Number	Answer	Mark
13(a)	(The graph shows) brittle – undergoes no/little plastic deformation/behaviour (before breaking) / breaks/fails just beyond/soon after limit of proportionality/elastic limit (1) (The graph shows) ductile – undergoes lots of/significant/large plastic deformation (before breaking) / able to undergo permanent deformation under tensile stress (1)	**2**
13(b)	Porcelain/vase/it is <u>brittle</u> (1) When broken it doesn't (permanently) deform/change shape/bend (or synonyms – but 'dent' is not sufficient) (No elastic deformation not sufficient) (1)	**2**
	Total for question 13	**4**

Question Number	Answer	Mark
14(a)(i)	State or show $E_p \rightarrow E_k$ (1) $mgh = ½ mv^2$ Or $gh = ½ v^2$ (1) Use of $mgh = ½ mv^2$ Or $gh = ½ v^2$ (1) $v = 3.4$ (m s^{-1}) [no ue] (1) Calculation using $v^2 = u^2 + 2as$ scores 0 marks Use of $g = 10$ N kg^{-1} gives 3.46 m s^{-1}, 3.5 m s^{-1}, max 3 marks Do not credit bald answer (Candidates may calculate in steps using $m = 40$ kg, mark 2 becomes use of $E_p = mgh$ and mark 3 becomes use of $E_k = ½ mv^2$) <u>Example of calculation</u> $E_p = E_k$ $mgh = 1/2\ mv^2$ $gh = 1/2\ v^2$ 9.81 N kg^{-1} x 0.6 m = $1/2\ v^2$ $v = 3.4$ m s^{-1}	**4**
14(a)(ii)	All $E_p \rightarrow E_k$ / no friction/air resistance ***I*** no stretch of cable / $u = 0$ / no push at start / no energy transferred to other forms (1) (No energy lost is not sufficient.)	**1**
14(b)(i)	Label 2 x tension (T) parallel to cable and **away** from P only (1) Label weight / pull of child / W / mg vertically downward (1) One correct and one incorrect scores 1 mark. Two correct and one incorrect scores 1 mark. Two incorrect scores 0. Ignore unlabelled arrows.	**2**
14(b)(ii)	Use of $W = mg$ (1) Use of correct trigonometrical function (T sin 2 = W/2)(accept with missing factor 2, i.e. T sin 2º = W)(do not accept tan) (accept cos 88)(1) Force = 5600 (N) [no ue] (1) Accept calculation of 11 200 N divided by 2 at the end for full marks only if accompanied by an explanation, such as 'there are two cables' <u>Example of calculation</u> $W = mg$ W = 40 kg x 9.81 N kg^{-1} = 392 N T sin 2º = $W/2$ T = 392 N / 2 x sin 2º T = 5621 N	**3**
	Total for question 14	**10**

Question Number	Answer	Mark
15(a)(i)	3 correct labelled arrows: Upthrust, *U* (1) weight, *W*, *mg* (1) (viscous) drag, water resistance, viscous force, V, F, D [upwards] (1) ('resistance' not sufficient) Each incorrect force decreases the maximum possible mark by one U and D can share an arrow. Arrows need not touch particle. Ignore unlabelled arrows.	**3**
15(a)(ii)	upthrust + drag = weight or with unambiguous symbols (allow ecf from diagram) (1) forces in equilibrium / balanced forces / no resultant force / no acceleration / constant velocity (1)	**2**
15(b) (i)	Down and along (1) (shape of trajectory not important)	**1**
15(b)(ii)	Lines crossing, eddies, sudden changes in direction, change in direction > 90°, lines disappearing and appearing (1) Turbulent flow can be seen at any position	**1**
15(b)(iii)	Laminar const vel at a point/no eddies/lines don't cross, but turbulent keeps changing direction/eddies/lines cross (1) Some comparison required. Smooth/streamlined/chaotic not sufficient descriptors	**1**
15(b) (iv)	Turbulent flow → eddies/continual changes will disturb particle back into the flow / stop particle from continuing downwards / lifts particle (1) Answer should imply some upwards force/motion imposed on the particle	**1**
	Total for question 15	**9**

Question Number	Answer	Mark
16(a)	Free body force diagram, arrows must begin at the point shown – including: weight vertical, (W, mg, gravitational force – not 'gravity') friction and/or air resistance parallel to slope upwards, (D, V, F) normal contact force perpendicular to slope upwards. (ncf, N, R) 3 correct forces = 2 marks, 1 or 2 correct forces = 1 mark, Ignore arrows not coming from point Each incorrect force (e.g. pull down slope) decreases the maximum possible number of creditable forces by one Ignore upthrust.	**2**
16(b)(i)	Use of equations of motion sufficient to lead to answer (1) $a = 0.9$ (m s^{-2}) (1) Example of calculation $s = ut + ½\ at^2$ 11 m = ½ a x (4.9s)^2 $a = 0.92$ m s^{-2}	**2**
16(b) ii)	Use of $F = ma$ (1) F = 36 to 40 N (1) Example of calculation $F = ma$ F = 40 kg x 0.92 m s^{-2} F = 37 N	**2**
16(c)(i)	Use of trigonometrical relationship (200 cos 20º) to resolve force (1) F = 152 N (1) Example of calculation Horizontal component of force = 200 N x cos 20º = 188 N 37 N = 188 N – resistive force resistive force = 151 N	**2**
16(c)(ii)	Use of work = force x distance (1) Use of work / time (1) Power = 420 W (1) For $P = Fv$, Find (or use) ave velocity (1), use of $P = Fv$ (1), correct answer (1) Example of calculation Work = force x distance = 188 N x 11 m = 2070 J Power = work / time = 2070 J / 4.9 s = 422 W	**3**
	Total for question 16	**11**

Question Number	Answer	Mark
17(a)(i)	Horizontal component of velocity = 7.5 cos 50 = 4.8 (m s^{-1}) (1)	**1**
17(a)(ii)	Vertical component of velocity = 7.5 sin 50 = 5.7 (m s^{-1}) (1) May use Pythagoras or tan for second component calculated	**1**
17(a)(iii)	Use of appropriate equation of motion, e.g. $v = u + at$, leading to time of flight (1) Time of flight OR double distance travelled half way (1) Use of velocity = distance / time (1) Distance = 5.6 m to 6.1 m (1) Correct answer from range formula 4/4, incorrect answer from range formula 0/4 <u>Example of calculation</u> $v = u + at$ 0 = 5.7 m s^{-1} + 9.81 m s^{-2} x t t = 0.58 s to max height time of flight = 1.16 s horizontal distance = horizontal component of velocity x time = 4.8 m s^{-1} x 1.16 s = 5.6 m (Using 'show that' values gives 6.12 m)	**4**
17(b)(i)	Use of $E_k = ½ mv^2$ (1) kinetic energy = 41 J (1) <u>Example of calculation</u> $E_k = ½ mv^2$ m = 2.24 kg – 0.79 kg = 1.45 kg E_k = ½ x 1.45 kg x (7.5 m s^{-1})^2 = 40.8 J If answer calculated from difference between 2 kinetic energies, allow first mark only.	**2**
17(b)(ii)	Not all the mass of liquid which left the bottle went that far / 7.5 m s^{-1} is the maximum speed (1)	**1**
17(b)(iii)	Air resistance / friction at neck (1) … could have caused the liquid to lose energy / so the true (initial) velocity is more than the calculated value / so the measured range was less (than it might otherwise have been) (Just 'energy lost' not sufficient – must be linked to some cause) (1)	**2**
	Total for question 17	**11**

Question Number	Answer	Mark
18(a)(i)	Straight line shown / constant gradient (1) (So) extension or change in length proportional to force (accept Δx or Δl or e proportional to F) / k constant. (NOT Length α force) (1) [Just stating $F = k\Delta x$ does not get the mark] (Yes, because extension or change in length proportional to force gets 2)	**2**
18(a)(ii)	Indication of use of (inverse) gradient, e.g. $k = F/\Delta x$ or with values obtainable from graph (accept extension/force for first mark) (1) Substitution of values as force/extension (1) Stiffness = 0.66 to 0.80 (N m^{-1}) [no ue] (1) Range is due to tolerance of + or – half a square on reading graph. [Allow answers of 0.7 N m^{-1} or 0.8 N m^{-1} without extra sig fig if that is the exact value produced from their figures, e.g. from F = 0.7 N, where length = 260 cm] Example of calculation $k = F/\Delta x$ k = 0.8 N / (2.7 m – 1.6 m) k = 0.8 N / 1.1 m = 0.73 N m^{-1} (Read graph to half a square)	**3**
18(a)(iii)	Use of $E = \frac{1}{2} F\Delta x = \frac{1}{2} k(\Delta x)^2$ OR Use of an area between a line and an axis (allow line shown and force axis) (1) Identify correct extension OR correct area (1) E = 0.31 J to 0.35 J from $E = \frac{1}{2} F\Delta x$ E = 0.27 J to 0.40 J from $\frac{1}{2} k(\Delta x)^2$ if k in range [allow ecf for k] (1) Example of calculation $E = 1/2\ F\Delta x$ = 0.5 x 0.7 N x (2.55 m – 1.6 m) = 0.33 J	**3**
18(b)(i)	Coils at top support coils below (1) (So) a greater force acts (on top coils) (1) Coils at the top support the weight of the coils below as well = 2 marks	**2**
18 (b)(ii)	Clearly below centre and above bottom – accept if no label (1)	**1**
18 (b)(iii) (1)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Ball acted on by its weight (alone) / by gravity (alone) (1) Top coils acted on by their weight and/also acted on by elastic/tension force / force due to extension of coils (1) So the acceleration is greater (1) Energy explanation – max 2 for ball, transfer to ke from gpe alone - 1 mark for top coils, transfer to ke from gpe and elastic pe – 1 mark (allow 'has' energy instead of transfer to ke)	**3**
18(b)(iii) (2)	They are acted on by weight downwards and (elastic) force upwards/ the forces on them are/remain balanced (1)	**1**
	Total for question 18	**15**

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